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(पहला पुनरीक्षण)

Code of Practice of Rehabilitation of Tubewells

(First Revision)

ICS 65.060.35; 73.100

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

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Diamond Core and Waterwell Drilling Sectional Committee, MED 21

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Diamond Core and Waterwell Drilling Sectional Committee had been approved by the Mechanical Engineering Division Council.

This code of practice was first published in 1986. The standard has been revised to incorporate the latest development in rehabilitation of tubewells.

The composition of the committee responsible for the formulation of this standard is given in Annex A.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

CODE OF PRACTICE OF REHABILITATION OF TUBEWELLS

(First Revision)

1 SCOPE

This standard lays down the guidelines for rehabilitation of sick tubewells.

2 TERMINOLOGY

For the purpose of this standard following definition shall apply.

Tubewell Rehabilitation — Restoring a well to its most efficient condition by various treatments.

It is important to monitor changes in the operating characteristics of the well, because the well can deteriorate to the point where rehabilitation is difficult, if not impossible. Generally, if the specific capacity of a well declines by 25 percent, it is time to initiate rehabilitation procedures. The necessity for well rehabilitation depends on the effectiveness of the well maintenance programme and how faithfully it has been followed. So many variables are involved that a single maintenance programme cannot be devised suiting every hydrogeologic condition and every type of well. Effective maintenance programme begins with well construction record, and operating record over the period since installation. The entire work of rehabilitation must be done in constant consultation with the owner of the well.

3 CAUSES OF DETERIORATING WELL PERFORMANCE

Six major problems which occurs over time and lead to deterioration of well performance are as follows:

a) Reduction in well yield;
b) Plugging of the formation around the well screen;
c) Onset of sand pumping;
d) Structural collapse or rupture of the well casing or screen;
e) Condition of the pump; and
f) Corrosion and incrustation of the screen/ pipe assembly.

It is, thus, of immense importance to establish the cause of deteriorating condition of the well before undertaking rehabilitation plan. Also, it may be that more than one problem occur at the same time.

4 DATA COLLECTION

Prior to field investigation collect all possible information regarding the well from the owner. This data may include:

a) Date of construction of the tubewell;
b) Method of drilling;
c) Lithological log/geophysical log;
d) Sieve analysis of aquifers screened, if done;
e) Sieve analysis of filter pack if used and the volume packed;
f) Well assembly chart with pipe material and diameter, screen material and diameter, shape and size of screen opening, smallest width of slot opening, etc.;
g) Centring guides diameter and location on casing pipes;
h) Seals and packers, if provided;
j) Methods of development with periods;
k) Chemical treatment given at the time of construction/development;
m) Pumping test results at the end of development. These may include pre pumping water level; rate of discharge with corresponding draw down after about one hour pumping for three to four different discharge rates;
n) Sand content and colour of the discharged water at the beginning of the pumping test and later at various discharge rates;
p) Final operating pump lowered in the well along with its rated yield, head, diameter, column pipes, position of the pump in the well, rated electrical consumption etc.;
q) Historical operational discharge and draw down;
r) Historical record of non-pumping water level;
s) Record of sand content in discharged water with time during operational pumping;
t) Results of the initial and present analysis of the well water;
u) Well sounding at the end of the pumping test before acceptance by the owner; and

w) Any other record maintained during period of operation till the present condition reached. This may include periodic water level record, discharge rate, water quality, sand content, position of pump in the well, electrical consumption, periodic maintenance etc.

5 FIELD INVESTIGATION

The field investigation must start from the discussions with the owner, operator of the pump and concerned staff regarding the kind of trouble they are facing. Further investigation should be based on the problem faced/informed. The following field investigations and data collection shall be under taken for arriving at the cause of trouble in the well:

a) Collect hydrogeological data and water level trends etc., from available source, if any;
b) Operate the pump and collect information for about an hour or till the discharge can be obtained whichever is earlier, on pre pumping water level, discharge rate, change in discharge with time, fluctuation in discharge if any, colour of the water discharged, sand content if any, the units of electricity consumed, any abnormal sound of the pump during operation, depth to pumping water level if facility available, etc.;
c) Collect a water sample and get it analyzed chemically and bacteriologically. Also record the smell and temperature of the discharged water. Then get the pump removed and make record of depth to water level and clear depth of the well structure;
d) If borehole camera is available, videography of the well structure shall be undertaken for locating any evidence of depth wise damage to the casing or screen, incrustation, organic growth or any deposit on the casing or screen. Note of any floating material such as algae, iron bacteria or similar organism shall be made; and
e) Examine the condition of the column pipes of pump, drive shaft, bearing, spiders, and pump bowl for excessive accumulation of ferric or ferrous oxide. Such deposits must be got examined on urgent basis for possible organism involved. The pump parts shall also be examined for any pitting, graphitization, cavitation and wear and tear of impellers. The flanges and glen packings of column pipes shall also be examined for any damage.

6 ANALYSIS OF THE DATA COLLECTED

Based on the discussions and the data collected possible cause of well trouble/problem shall be ascertained. A critical examination of the borehole videography is likely to pin point the basic cause of well trouble. Some major observed problems and their causes are as under:

6.1 Reduction in Well Yield

The very first step shall be to compare current specific capacity of the well with the original or any past value. If the value is nearly same as original then the well structure needs no action and the pump shall be checked for its malfunction. If specific capacity is significantly lower, then the reduction in well yield could be due to the following:

a) *Lowering of Water Level of the Aquifer in the Area* — In this case nothing shall be done except lowering a higher capacity pump to deeper level to obtain the desired yield.
b) *Infilling in the Well, Blocking Part or Full Screen* — This could be due to many reasons and may require specific treatment.
c) *Plugging of Formation or Filter Pack Outside the Well Screen* — It is difficult to diagnose this situation, however, if no other reason is obvious, the reduction in specific capacity could be due to this reason.

6.1.1 *Malfunctioning of Pump or its Components*

Malfunctioning of the pump could be due to following:

a) Improper adjustment of the impeller due to wear or other causes;
b) A hole in the column pipe and or; and
c) Erosion or corrosion of the impeller or bowls. In some cases hole in the column pipe or loose glen packings is also seen.

6.2 Onset of Sand Pumping

Onset of sand pumping may be due to poor designing or incomplete development of the well. Localized corrosion of well screen or in some cases incrustation on part of a screen may be the cause of sand pumping. This can be verified from the borehole photography. This situation results in higher entrance velocity through the screen causing fines from the aquifer to move towards the screen and finally in the well yield, these ultimately clog the formation, gravel and screen opening. Corrosion and incrustation are major causes of well failure after onset of sand pumping.

6.3 Structural Collapse or Rupture of the Casing or Screen

The camera videography of the well structure is most appropriate for locating casing/screen rupture. But other methods, such as, lowering of a dolly of one nominal smaller casing/screen can precisely locate the collapse position. The dolly shall not pass the collapse part of pipe casing. Whenever a rapture takes place the inside pipe assembly is filled with filter media

used surrounding the well casings. This can be noticed during pumping also when the sand discharged with water is coarser than screen opening. Once the rupture or collapse position is ascertained the rehabilitation process can be planned. This normally does not happen but may occur in some wells.

6.4 Corrosion and Encrustation of the Pipes and Screens

These problems are most difficult to ascertain especially encrustation. The corrosion of screens can be identified with increased sand pumpage and encrustation with reduced yield. But the best result could be obtained from the videography of the well structure.

7 METHODS OF TREATMENT/ REHABILITATION

Once the cause of problem is identified the treatment shall be initiated.

7.1 Infilling in the Well

Infilling in the well blocking part or full screen shall be removed by bailing or compressed air. The operation shall be carried out slowly not damaging the screens. However, if the well does not get clear of infilling, look for any damage to the well structure. The borehole photography shall then be studied to locate the type of damage and place of damage. At the end, the well shall be redeveloped by appropriate method (compressed air or over pumping) to make it give sand free discharge. After the development procedure the well shall be tested for obtaining specific capacity. Also the clear depth of the well shall be again determined.

7.2 Physical Plugging of Formation or the Screen

a) *Mechanical Methods*

1) Wire brushing or other means of mechanical scrapping shall be applied to remove encrustation. The loosened material then shall be removed by bailing or air lifting.
2) High velocity jetting shall be done against screens to break and remove the plugging of screens if it is due to slit and clay particles.
3) Polyphosphates and surfactants — Sodium polyphosphates are crystalline and glassy. Crystalline polyphosphates are sodium acid pyrophosphate (SAPP), tetra sodium pyrophosphate (TSPP) and sodium tri polyphosphate (STP) along with chelating compounds have the power to treat clay plugging problems. Sodium hexametaphosphate (SHMP) is a glassy phosphate that is commercially available and shall be used for treating wells. The suggested mixture of chemicals for 1 000 liters of water in the well is :

The sodium hexametaphosphate	16 kg
Sodium carbonate	4 kg
Sodium hypochlorite 5.25 percent	1 l
Wetting agent – Pluronic F-68	1 kg

Estimate the water in the well and the gravel pack and also the chemical required.

Mix all the chemicals in 500 lt of warm water in a black or plastic tank. Then dilute it with cooler water. Pour the prepared solution into the well with a 38/50 mm diameter plastic or iron tremie pipe placed such that its bottom is 1.5 m above the bottom of the well. The pipe is then raised by about 3 m and procedure is repeated until the volume of water in well is replaced by the solution. At the end pour in water in the well that is equal to about half of the water in casing pipe.

Agitation of the water and the chemical shall then be done at an interval of about 1 h for about 6 h to achieve the desired results. This agitation can be done by compressed air method or pump. However, it must be ensured that the chemical is not discharge out in first few hours of agitation. The discharged water and chemical shall be guided back into the well after removal of sediments. After 6 h the well shall be pumped to waste to remove all chemicals from the well.

7.3 Sand Pumping

Redevelop the well with established well development method. High velocity jetting is very effective in many cases. However, if the established cause of sand pumping is incrustation, acid treatment is most appropriate. If the cause of sand pumping is enlarged slot opening or rupture in the well structure, following procedure should be adopted.

7.3.1 The sand pumping may be due to a broken screen or casing or faulty packer. The location and location of the break should be determined and verified by photographic survey. In some cases the break will be associated with displacement of the axis and possibly deformation of the casing and screen. In such a case run a hydraulic or mechanical casing swage into the well to round out and if possible realign the casing or screen. In such cases telescope 3 m or more of liner with neoprene rubber seals sized to both the smaller and larger casing into the smaller casing. Another treatment is to swage a liner into the smaller casing with the upper end extending about 1 m above the reducer or original packer and the seal the two with cement grout.

7.3.2 If problem is due localized enlargement of screen slots or a hole in the casing, a liner should be swaged in place opposite the corroded section.

7.3.3 If sand pumping is due to settlement and bridging of filter pack, it is recommended to vigorously redevelop the well by injecting large quantity of water into the pack from surface.

7.3.4 Malfunctioning of the pump should be rectified by removing the pump from the well and get it repaired or replaced. All column pipes should be thoroughly examined and glen packings replaced.

7.4 Acid Treatment

If all other possibilities are eliminated, the problem of reduced yield is incrustation of the screen or pack or both. Scrap the screens with steel disc or steel brush on a drill stem and collect the scrapings. Examine the scrapings to determine the nature and chemical composition of the incrustation. It may be primarily of calcium, magnesium and iron carbonates or iron hydro oxide. In such a case the acid treatment to rehabilitate the tubewell may be possible. The acid treatment shall be applied with a team of experts.

7.4.1 The choice of the acid has to be one of the followings:

a) Muriatic or hydrochloric acid (HCl) 27.92 percent;
b) Sulfuric acid (H_2SO_4); or
c) Sulfamic acid [amino sulfamic (H_2NSO_3H)].

   Along with acid the chelating agents should be chosen from the following:

   1) Citric acid [$(COOH)CH_2\ C(OH)\ (COOH)\ CH_2$ COOH];
   2) Phosphoric acid (H_3PO_4);
   3) Tartaric acid [HOOC $(CHOH)_2$ COOH];
   4) Rochelle salt ($KNaC_4H_4O_6$); or
   5) Glycolic acid $HOCH_2$ COOH.

      Usual amount of chelating agent to be used is as under:

      i) 1 kg of agent to 15 kg of sulfamic powder;
      ii) 1 kg of agent to 5 l of 15 percent HCl; or
      iii) 2 kg of agent to 5 l of H_2SO_4

7.4.2 Limitations for acid treatment are as follows:

a) It is not recommended to use sulfuric acid as the reaction of the sulfuric acid with calcium carbonate forms calcium sulfate which is relatively insolvable and difficult to remove from the well;
b) Inhibited sulfuric acid is aggressive to most metals, particularly copper alloys; and
c) Muriatic or hydrochloric acid even in inhibited form should not be used on wells having type 304 or 308 stainless steel screens as it causes stress corrosion cracking of these alloys. This could, however, be safely used on wells with 316 or 321 stainless steel screens.

7.4.3 *Procedure for Application*

7.4.3.1 *Muriatic acid*

a) Muriatic or hydrochloric acid 27.92 percent — Full strength acid is to be used. The volume of the water in the well below top most screen is estimated and 2-2.5 times as much acid as water is placed in the well through a plastic or black iron pipe;
b) 1 kg of diethylthiourea or a similar inhibitor should to be put in the well per 15 000 l of the acid used along with the chelating agent as given above;
c) The acid should be left in the well for 4 to 6 h;
d) The well then is surged with surge block for 15 to 20 min at about 1 h interval; and
e) The solution in the well is then pumped or bailed from the well to waste.

7.4.3.2 *Sulfamic acid*

a) Estimate the volume of water in the well below the top of screen;
b) For every 500 l of water mix 150 kg of sulfamic acid, 10 kg of citric acid, 8 kg of diethylthiourea, 1.6 kg of pluronic F 68 or L 62 and 70 kg of sodium chloride;
c) Dissolve the chemicals in water at the surface and keep them at surface in water the total of which adds up to equivalent of water in the casing and careen;
d) The slurry is pumped or poured into the well through a black iron or plastic pipe which initially extends to the bottom of the well. The pipe is then raised 2 to 3 m stage as sufficient solution is added to displace an equivalent volume of water in the well;
e) The solution is left in the well from 12 to 24 h during which time it is surged for 15-20 min at hourly interval;
f) Test the solution in the well and when the pH value drops between 6 and 7 the acid should be considered exhausted;
g) Pump out the solution to waste from the well and observe its performance. If marked improvement is observed develop the well and sterilize and put back to use;
h) If the well has only marginally improve another dose of acid treatment can be given; and
j) When acidizing a well keep a tank of sodium bicarbonate handy for any accidental spillover of the acid on men and material.

7.4.3.3 *Chlorine treatment*

Where blockage of screen is caused by slime forming organism, chlorine gas may be an effective treatment. 40 to 60 kg pressure gas cylinder should usually be used. The gas cylinder should be connected through a plastic or black iron pipe which extends to nearly bottom of the well. Open the cylinder slowly such that discharge of the cylinder should not exceed 16 kg per 24 h. After the cylinder is exhausted neutralize the chlorine in well by adding sodium hydroxide or calcium hydroxide prior to pumping to waste. Similar results can be obtained by adding hypochlorite solution. Sufficient hypochlorite to produce 1 000 ppm chlorine in well water should be poured or pumped into the well. Surge the well for 30 min and leave the solution for 6 h. After this the well should be pumped to waste.

7.5 Explosives for Hard Rock Wells

4 kg shots of 50-60 percent dynamite should be used at 1.5 m interval within the open hole against hard rock only and not against shales. Also avoid shooting within 15 m distance to casing pipe. After shooting starting from bottom the well should be bailed clean and developed.

NOTE — Storage and use of explosives including dynamite for civilian purposes are regulated under provisions of *Explosives Act*, 1884 and *Explosive Rules*, 2008 and as amended with an exception where the provisions of Mines Act are applicable.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Diamond Core and Water Well Drilling Sectional Committee, MED 21

Organization	*Representative(s)*
Geological Survey of India, Kolkata	Shri Ajay Agarwal (***Chairman***) Shri Anup Kumar Johri (*Alternate*)
In Personal Capacity, Chandigarh	Shri M. Chandra Jindal
AMKO Mining And Drilling Equipment Pvt Ltd, Mumbai	Shri M. G. Kuvawala Shri H. M. Kuvawala (*Alternate*)
AQSEPTENCE Group (India) Pvt Ltd (Formaly Known As Johnson Screens India Pvt Ltd)	Shri Rakesh Arora Shri Anil C. Shah (*Alternate*)
Atlas Copco (I) Ltd. Pune	Shri Shudhanshu Nigam Shri S. Datta Majumdar (*Alternate*)
Atomic Minerals Directorate For Exploration And Research, Hyderabad	Shri A. B. Anand Shri P. S. Chattopadhyay (*Alternate*)
Central Ground Water Board, Faridabad	Shri Alok K. Dube Shri Sivashankar (*Alternate*)
Central Water Commission, New Delhi	Superintending Engineer Director (*Alternate*)
Drilbits International Private Limited, Nashik	Shri Y. V. Ramana Murthy Shri Tushar Paul (*Alternate*)
Drillmax Rigs Pvt Ltd, Mumbai	Shri R. K. Bijlani Shri R. B. Desai (*Alternate*)
DTE of Mines And Geology, Udaipur	Shri N. K. Parihar Shri N. K. Jonwal (*Alternate*)
Indian Pump Manufacturers Association, Mumbai	Shri Yogesh Mistry Shri Utkarsh A Chhaya (*Alternate*)
Indian School of Mines, Dhanbad	Shri A. K. Pathak
Kores (India) Ltd, Mumbai	Shri Sandeep Dholi
Mecon Limited, Jharkhand	Shri B. k. Sinha
Mineral Exploration Corporation Ltd, Nagpur	Shri S. M. Joshi Shri J. G. Jangla (*Alternate*)
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RITES Ltd, Gurgaon	Shri S. Kunal Shri P. C. Dewli (*Alternate*)
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Sandvik Smith Asia Ltd, A.P.	Shri Rangayya Naidu Shri N. Bhaskara Reddy (*Alternate*)
The Singareni Collieries Co Ltd, Kothagudem	Shri V. Rama Rao Shri Subhash Chandra (*Alternate*)

Organization	*Representative(s)*
Water & Power Consultancy Services (India) Ltd, Gurgaon	SHRI ANUPAM MISHRA SHRI J. K. RAI (*Alternate*)
BIS Directorate General	SHRI RAJNEESH KHOSLA, SCIENTIST 'E' AND HEAD (MED) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary

MS KHUSHBU JYOTSNA KINDO
SCIENTIST 'C' (MED), BIS

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices: *Telephones*

Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg CHANDIGARH 160019	265 0206 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
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